R&D 7060 MA-01

(2)

Amsterdam

January 27–29, 1993

Modern developments in complex analysis and related topics

DAJA45-93-M-0137

Conference on the occasion of the 70th birthday of

Prof. dr J. Korevaar

Organization

Accesion For	
NTIS CRA&I	X
DTIC TAB	☐
Unannounced	☐
Justification per form 50	
By	
Distribution /	
Availability Codes	
Dist	Avail and / or Special
A-1	

Organizing Committee

F. van der Blij
M.A. Kaashoek
J.J.O.O. Wiegerinck

Supported by

European Research Office United States Army
Koninklijke Nederlandse Akademie van Wetenschappen
Office of Naval Research European Office
Shell Nederland B.V.
Universiteit van Amsterdam
Wagons-lits Reizen
Wiskundig Genootschap

Office of Naval Research Europe

Koninklijke Nederlandse Akademie van Wetenschappen

Shell Nederland B.V.

European Research Office United States Army

WISKUNDIG GENOOTSCHAP

Wagons-lits Reizen

UvA DE UNIVERSITEIT VAN AMSTERDAM.

Introduction to the program of the conference Modern Developments in Complex Analysis and Related Topics, on the occasion of the 70th birthday of professor J. Korevaar

Modern developments in complex analysis, but when did they begin to be modern? Was it in 1902, when the first printing appeared of *A course in Modern Analysis* by E.T. Whittaker and G.N. Watson? Or was it in 1960 with the *Foundations of Modern Analysis* by J. Dieudonné?

For this conference, let us put the beginning somewhere in between, in 1923, just after 1922 when L. Bieberbach's textbook *Lehrbuch der Funktionentheorie* was published, and just before the year 1924, which came with a new printing of Goursat's *Cours d'Analyse*. (In this printing the proof of the transcendence of the number e was replaced by other topics in analysis that were perhaps of more inportance for the students.)

In 1923, Jacob Korevaar was born in a small Dutch village called Lange Ruige Weide. Between 1929 and 1940 he went to primary school and in Dordrecht to secundary school, where his mathematics teacher was C. Visser, later professor in analysis in the universities of Delft and Leiden. Visser was specially interested in the theory of functions of a complex variable in the French tradition.

In that pre-war period several classical textbooks on Modern Analysis (of complex variables) were published and they were studied by Jaap Korevaar during the years that he was a university student, starting in 1940 and in some respect ending with his "promotion" in 1949 under guidance of H.D. Kloosterman at Leiden University.

We recall some of these textbooks: G. Pólya und G. Szegö: *Aufgaben und Lehrsätze aus der Analysis I, II* (1923), E.C. Titchmarsh: *The theory of functions* (1932), R.E.A.C. Paley and N. Wiener: *Fourier transform in the complex domain* (1934), G. Doetsch: *Theorie und Anwendung der Laplace-Transformation* (1937), J.L. Walsh: *Interpolation and approximation by rational functions in the complex domain* (1935).

But one could easily mention many more papers and books that had an influence on the mathematics education of Jaap Korevaar. In that time some actual problems in analysis were: the quest for an elementary proof (that is one without use of the theory of complex functions) of the prime number theorem; the general theory of Tauberian theorems; the approximation of functions by functions of prescribed type. Approximation as a topic with its own interest and flavor but also in the faint hope that such theorems could give more information on the properties of the limit function. Everybody hoped(s?) to find in a certain way an opening to the Riemann-hypothesis.

And, of course, there was the urgent question whether an analytical correct theory of the Heaviside-calculus, used by electric engineers, could be given. After the end of World War II there was a lot of news. To recall only two items we mention the Erdös-Selberg elementary proof of the prime number theorem and the book of L. Schwartz: *Théorie des Distributions I, II* (1950).

These topics (and many others) of the theory of functions of one complex variable can be found in the papers of Jaap Korevaar and in the topics of this conference.

In modern times old conjectures were proved. I think of the Bieberbach conjecture in the theory of functions of one complex variable, and new topics were proposed. I mention an item like wavelets and the new methods in the theory of functions of several complex variables.

Earlier, of course, the Cousin-problems were proposed, and there was the line of F. Conforto: Abelsche Funktionen und Algebraische Geometrie. But that subject came in the hands of number theorists and the people of Lie-groups and of algebraic geometry. The line of Behnke, Stein, Remmerts et al. is wellknown. In the French tradition is the book of Henri Cartan: *Théorie élémentaire des fonctions analytiques d'une ou plusieurs variables complexes* (1961). Also, we must certainly mention the book of L. Hörmander: *An Introduction to Complex Analysis in several Variables* (1966) as an essential landmark.

Now I have to stop with history; you can find many more details in the recent publication of Henry Cartan in book of Peter Hilton et al.: *Miscellanea Mathematica* (1991). In this *Festschrift* there is also the publication of the correspondence of J.P. Serre and H. Cartan concerning "Les petits cousins" . But you can also find nice historical facts in the paper of Jaap Korevaar in the Nieuw Archief voor Wiskunde vierde serie 7 (1989) p.83-89. It would be interesting to classify the more recent papers of Jaap Korevaar and the papers presented on the occasion of his 70th birthday in a historical setup. But one must not do history on subjects that are too recent. Later, on the occasion of a 80th birthday, perhaps more? It could be done by one of the participants of this conference!

F. van der Blij

Acknowledgements

On behalf of the Organizing Committee I would like to express my gratitude to those persons, organizations and companies that made this conference possible.

The financial support of our sponsors is gratefully acknowledged. I would also like to thank the Departments of Mathematics of the Katholieke Universiteit Nijmegen, Technische Universiteit Delft and Vrije Universiteit Amsterdam who were so kind to invite a number of visitors interested in this conference precisely at the right time. I am also grateful to the Vrije Universiteit Amsterdam for reproducing the program booklet.

Philo Zijlstra put a lot of effort into handling the secretarial work. Arno Kuijlaars helped out at a crucial moment by editing the conference program and abstracts. I thank them both.

Finally, I would like to take this opportunity to thank Jaap Korevaar for guidance and inspiration during so many years. In more than one way he is the key to this conference.

Jan Wiegerinck

Location

The conference will be held at the University of Amsterdam in the "Roeterseiland Complex" on January 27, 28 and 29, 1993. On Wednesday, January 27, and Thursday, January 28, the lectures will be given in the B.C.P. Jansen Building, room MC3, Plantage Muidergracht 12, Amsterdam. The Friday morning lectures will be in the Mathematics Department, Euclides Building, room P2.27, Plantage Muidergracht 24, Amsterdam, and the Friday afternoon lectures in the A-Building, room A, Roetersstraat 15, Amsterdam. Because of reconstruction works, the A-Building can only be entered from the Nieuwe Achtergracht.

The Roetersciland Complex can easily be reached by public transportation. From Metro/Light Rail stop "Weesperplein" it is a 7 minute walk to the Plantage Muidergracht, or from "Weesperplein" one may take tram no. 7 to Plantage Muidergracht (second stop). From Central or Amstel Station one may reach "Weesperplein" by Metro/Light Rail. From Metro/Light Rail stop "Waterlooplein" it is a little further, but one may take there trams no. 9 or 14 and get off at Plantage Kerklaan (second stop). Tram no. 9 is actually coming from the Central Station.

Most foreign participants of the conference will either stay in Hotel Altea, J. Muyskenweg 10, Amsterdam, or in Hotel Barbacan, Plantage Muidergracht 81, Amsterdam.

Lunch

Lunches will be served in the "Symposion", Roetersstraat 11, around 1 pm. For exact times please consult the detailed program.

Conference dinner

On Thursday, January 28, the conference dinner will be served in the Restaurant "Osaka", De Ruyterkade 7, Amsterdam, close to the Central Station. Dinner starts at 7 pm.

Note that on Wednesday and Friday no dinner has been organized for the participants of the conference.

Reception

On Friday, January 29, a reception is offered by the Department of Mathematics and Computer Science of the University of Amsterdam, on the occasion of the retirement of Prof. dr J. Korevaar. This reception is held in the "Spiliazaal", Roetersstraat 11 and starts around 4 pm.

Tour

If sufficiently many people are interested, we plan to organize an exploration of Amsterdam on Saturday, January 30. If you want to participate, please contact one of the organizers.

Proceedings

We would like to ask the participants to submit an extended abstract of their lecture for publication in the Proceedings of the Conference. These Proceedings will appear in the Universiteit van Amsterdam Mathematical Report Series, or if justified by size and contents, in a more formal publication.

A special volume of the journal "Indagationes Mathematicae" dedicated to Professor Korevaar is in preparation.

Program

Wednesday, January 27

Zaal MC3
Plantage Muidergracht 12
Amsterdam

9:00 – 9:45	Registration and coffee
9:45 – 10:00	F. van der Blij (Utrecht) *Welcome*
10:00 – 11:00	W. Rudin (Madison) *Holomorphic embeddings of* $\mathbb{C}$ *in* $\mathbb{C}^n$
11:15 – 11:55	H.J. Alexander (Chicago) *Linking and holomorphic hulls*
12:05 – 12:45	B. Berndtsson (Göteborg) *Estimates for the* $\bar{\partial}$*-equation in the one-dimensional case*
12:45 – 14:00	Lunch (Symposion, Roetersstraat 11)
14:00 – 15:00	L. Zalcman (Ramat Gan) *Normal families revisited*
15:15 – 15:55	W.K. Hayman (York) *Integrals of analytic functions along two curves*
16:15 – 16:55	A.A. Gončar (Moscow) *Potentials and rational approximation*
17:10 – 17:30	B. Jöricke (Berlin) *Envelopes of holomorphy and CR invariant subsets of CR manifolds*

Thursday, January 28

Zaal MC3
Plantage Muidergracht 12
Amsterdam

9:00 - 10:00	W.A.J. Luxemburg (Pasadena) *Renewal sequences and the diagonal elements of the powers of positive operators*
10:15 - 10:55	J.J. Duistermaat (Utrecht) *Normal forms of symmetric systems with double characteristics*
11:05 - 11:45	P.L. Butzer (Aachen) *Bernoulli and Euler "polynomials" with complex indices and the Riemann Zeta function*
12:00 - 12:40	T.H. Koornwinder (Amsterdam UvA) *Uniform multi-parameter limit transitions in the Askey tableau*
12:40 - 14:00	Lunch (Symposion, Roetersstraat 11)
14:00 - 15:00	N.G. de Bruijn (Eindhoven) *Convolutions of generalized functions, applied to diffraction theory of crystals and quasicrystals*
15:15 - 15:55	I. Gohberg (Tel Aviv and Amsterdam VU) *Time dependent version of results in complex analysis and operator theory*
16:15 - 16:55	Z. Ciesielski (Sopot) *Fractal functions and Schauder bases*
17:10 - 17:30	A.G. Sergeev (Moscow) *Complexifications of invariant domains of holomorphy*
19:00 –	Conference dinner (Restaurant Osaka, informal dress)

Friday, January 29

Zaal P2.27
Plantage Muidergracht 24
Amsterdam

9:00 – 9:50	R.G.M. Brummelhuis (Leiden) *Approximate logarithmic convexity of means of solutions of elliptic equations*
10:00 – 10:20	T.L. McCoy (East Lansing) *Answer to a query concerning the mapping* $w = z^{1/m}$
10:40 – 11:00	G.G. Walter (Milwaukee) *Analytic representations of distributions using wavelets*
11:10 – 12:10	C.K. Chui (College Station) *Wavelets and affine frame operators*
12:10 – 13:30	Lunch (Symposion, Roetersstraat 11)

Zaal A
Roetersstraat 15
Amsterdam

13:30 – 14:30	T. Ganelius (Stockholm) *Tauber, Korevaar and the true nature of mathematics*
15:00 – 16:00	J. Korevaar (Amsterdam UvA) *Living in a Faraday cage*
16:00 –	Reception (Spiliazaal, Roetersstraat 11)

Linking and holomorphic hulls

H.J. Alexander (Chicago)

The idea of linking number goes back to Gauss. We apply it to the study of polynomial hulls in complex n-space and more generally to holomorphic hulls in Stein manifolds. As an example, suppose that X and Y are compact, disjoint, smooth oriented submanifolds of complex n-space, with a non-zero linking number, then the polynomial hulls of X and Y have a non-empty intersection. As an application of linking we obtain some known results, and extensions, on the topology of hulls.

Estimates for the $\bar{\partial}$-equation in the one-dimensional case

Bo Berndtsson (Göteborg)

We shall survey various ways to get estimates for solutions to the $\bar{\partial}$-equation in domains in C. Relations to the tangential $\bar{\partial}$-operator in two variables will also be discussed.

Convolutions of generalized functions, applied to diffraction theory of crystals and quasicrystals

N.G. de Bruijn (Eindhoven)

X-ray diffraction of crystals (and quasicrystals) can be described by Fourier theory and convolution theory for generalized functions. The idea is that a crystal is a generalization of the Poisson comb: a countable sum of delta functions in space, with the property that its Fourier transform has again such a discrete structure. One of course needs a theory of generalized functions (distributions) for this. Because of the symmetry in this particular problem it seems to be atractive to take a distribution theory with Fourier invariance properties. One of the classes of Gelfand-Silcv is a good candidate for it. It is the class that was represented in a different form by J. Korevaar's "Hermite pansions" and by the speaker's traces based on a semigroup of operators in a space of smooth functions. An adequate convolution theory for this class was given by A.J.J.M. Janssen.

Approximate logarithmic convexity of means of solutions of elliptic equations

R. Brummelhuis (Leiden)

In the course of their work on minimal field distributions of electrons on spheres, J. Korevaar and J. Meyers discovered that a suitable analogue of the classical Hadamard three circles theorem on logarithmic convexity of sup-norms of holomorphic functions on circles even holds for harmonic functions. They used this to prove a certain "propagation of smallness" property for harmonic functions on arbitrary domains. In this talk we will discuss their result and some generalizations to solutions of general second order elliptic PDE's.

Bernoulli and Euler "Polynomials" with Complex Indices and the Riemann Zeta Function.

P.L. Butzer* (Aachen), M. Hauss, M. Leclerc

The well-known Bernoulli numbers $B_n \equiv B_n(0)$ or, more generally, the Bernoulli polynomials $B_n(x)$, often defined via their exponential generating function

$$\sum_{n=0}^{\infty} B_n(x)t^n/n! = te^{xt}/(e^t - 1) \qquad (|t| < 2\pi),$$

play a fundamental role in combinatorial theory, finite difference calculus, numerical analysis, (analytical number theory, probability theory (where they were introduced); they practically occur in every field of mathematics. Not quite as popular as these are the Euler numbers $E_n \equiv 2^n E_n(1/2)$, or the Euler polynomials $E_n(x)$, defined via

$$\sum_{n=0}^{\infty} E_n(x)t^n/n! = 2e^{tx}/(e^t + 1) \qquad (|t| < \pi).$$

One of the outstanding applications of the Bernoulli numbers is the calculation of the Riemann Zeta function $\zeta(s) := \sum_{k=1}^{\infty} k^{-s}$, $Re\ s > 1$, at the even integers. In fact, for $s = 2m$, $m \in \mathbb{N}$, $\zeta(2m) = (-1)^{m+1}2^{2m-1}\pi^{2m}B_{2m}/(2m)!$. The main aim of this lecture is to introduce Bernoulli numbers B_α with complex index $\alpha \in \mathbb{C}$ or, more generally, Bernoulli "polynomials" $B_\alpha(z)$ with $\alpha \in \mathbb{C}$ and $Re\ z > 0$, as well as to study their properties and some applications. Starting point is the representation of the $B_n(x)$ for $x \in [0,1]$ as a Fourier series

$$B_n(x) = -2\ n! \sum_{k=1}^{\infty} (2\pi k)^{-n} \cos(2\pi kx - n\pi/2) \qquad (x \in \mathbb{R};\ n \geq 2).$$

The basic connection between the Zeta function and the Bernoulli numbers turns out to be $2\cos(\alpha\pi/2)\zeta(\alpha) = -(2\pi)^\alpha B_\alpha/\Gamma(\alpha+1)$, $\alpha \in \mathbb{C}$, $Re\ \alpha > 1$. The functional equation for the $B_\alpha(p/q)$, $p, q \in \mathbb{N}$, $1 \leq p \leq q$, will contain the (famous) functional equation for the Riemann Zeta function.

The $B_\alpha(z)$ are related to particular Dirichlet series and their Hilbert transforms, to fractional Stirling numbers of second kind, to the Hurwitz Zeta function $\zeta(s,a) = \sum_{k=0}^{\infty}(k+a)^{-s}$, $Re\ s > 1$, $0 < a \leq 1$, etc.

The extensions of $B_n(x)$, $E_n(x)$ to $B_\alpha(z)$, $E_\alpha(z)$ read for $\alpha \in \mathbb{C}$, $Re\ z > 0$,

$$B_\alpha(z) = -\frac{\Gamma(\alpha+1)}{2\pi i}\int_C \frac{we^{zw}}{1-e^w}\frac{1}{w^{\alpha+1}}dw, \qquad E_\alpha(z) = \frac{\Gamma(\alpha+1)}{\pi i}\int_C \frac{e^{zw}}{1+e^w}\frac{1}{w^{\alpha+1}}dw.$$

Here C denotes a loop beginning at $-\infty$, encircling the origin once in the positive direction, and returning to $-\infty$.

Wavelets and Affine Frame Operators

Charles K. Chui (College Station)

The development of wavelet analysis is somewhat similar to that of Fourier analysis. We will present wavelet analysis from the time-frequency point of view. For instance, anti-aliasing can be accomplished by oversampling. This operation, however, gives rise to redundancy. Hence, it is important to study the preservation of tight frames in oversampling a wavelet series representation. Two oversampling theorems will be discussed. Our approach is based on an investigation of the corresponding affine frame operators.

Fractal Functions and Schauder Bases

Z. Ciesielski (Sopot)

Approximation theory method for constructing fractal functions of given dimension will be presented. It is common knowledge that determining the *Hausdorff* or the *fractal* (*box*) dimension of a particular object like the graph of a function or parametric surface, is often a difficult task; e.g., the Weierstrass function. On the other hand determining these dimensions for some random objects like brownian motion trajectories appears easier. Typical result in our deterministic approach to investigating functions of given box dimension is the following:

Theorem. *Let* (ϕ_n) *be the Schauder basis in* $C[0,1]$ *normalized in the* max *norm and let for given* $f \in C[0,1]$

$$f = \sum_n f_n \phi_n.$$

Moreover, let $0 < \alpha < 1$ *and let for some finite* $C > 0$, *independent of* p,

$$\frac{1}{2^{\alpha j}} \frac{1}{C} \leq \left(\frac{1}{2^j} \sum_{2^j+1}^{2^{j+1}} |f_n|^p \right)^{\frac{1}{p}} \leq C \frac{1}{2^{\alpha j}} \quad \text{for} \quad 1 \leq p \leq \infty.$$

Then the box dimension of the graph of f *is equal to* $2 - \alpha$.

Similar results in several variables will be discussed and applications to fractional brownian motion will be given.

Normal form of symmetric systems with double characteristics

P.J. Braam (Oxford) and J.J. Duistermaat (Utrecht)

Let P be a (pseudo-)differential operator, acting on sections of an orthogonal vector bundle E over an n-dimensional manifold X. All objects will be smooth, that is, infinitely differentiable. Because our results will be of a (micro-)local nature, we may use a local trivialization of E, in which P is a square matrix of (pseudo-) differential operators. We will assume that in an orthogonal local trivialization the principal symbol $p(x, \xi)$ of P is a real symmetric matrix; this is the case in many applications.

An important scalar function on the cotangent bundle T^*X of X is

$$\Delta(x, \xi) := \det p(x, \xi),$$

the determinant of the principal symbol of P. Away from its zeros, P behaves as an elliptic system. The set $N \subset T^*X \setminus 0$ where Δ vanishes is called the *characteristic variety* of P. At points of N the *polarization space* $\ker p(x, \xi)$ has a positive dimension. At points $(x, \xi) \in N$ where $d\Delta(x, \xi) \neq 0$, the simple zeros of Δ, N is a smooth conical hypersurface in T^*X.

If $\dim \ker p(x, \xi) = k$, then Δ has a zero of order $\geq k$ at (x, ξ). Therefore, at the simple zeros of Δ, the polarization space is one-dimensional and, modulo elliptic factors, the analysis can be reduced to considering a scalar operator with simple characteristics. For such operators the analysis modulo smoothing operators can be reduced to analysis of the operator $\partial/\partial x_1$, through conjugation with an elliptic Fourier integral operator, cf. [3, Sec. 6]. The translation of these results to the polarization properties of singular solutions of the original system has been carried out by Dencker [2].

For effects which are truly specific for systems we therefore must turn to the singular part Σ of N, where $\Delta = 0$ and $d\Delta = 0$. For a generic symbol Σ is stratified and the top stratum is a smooth codimension 3 submanifold of T^*X, transversally to which N looks like a quadratic cone. Modulo elliptic summands, P can be reduced to a symmetric 2×2-system.

Our main result is that, modulo elliptic factors and for generic symbols, the full Taylor expansion of the principal symbol at Σ can be brought into the very simple standard form

$$p(x, \xi) = \begin{pmatrix} \mp\xi_1 \pm \xi_2 & x_1 \xi_3 \\ x_1 \xi_3 & \xi_1 + \xi_2 \end{pmatrix}.$$

The normal form is achieved replacing P by APA^T for an elliptic Fourier integral operator A. Note that in this case

$$\Delta = \mp{\xi_1}^2 \pm {\xi_2}^2 - x_1^2 {\xi_3}^2.$$

The standard form for Δ has been obtained before by Arnol'd, cf. [1, Sec. 8.1-8.4].

The normal form for P suggests that the solutions behave as if the system were equal to

$$P = \begin{pmatrix} \mp\frac{\partial}{\partial x_1} \pm \frac{\partial}{\partial x_2} & x_1 \frac{\partial}{\partial x_3} \\ x_1 \frac{\partial}{\partial x_3} & \frac{\partial}{\partial x_1} + \frac{\partial}{\partial x_2} \end{pmatrix}.$$

Our goal is to understand properties of the solutions, such as propagation of the polarization of high-frequency solutions, by analyzing this model system. This information should complement the results on propagation of singularities obtained by [4] using energy estimates.

References

[1] V. I. Arnold: Singularities of Caustics and Wave Fronts. Mathematics and its Applications, Kluwer, 1990.

[2] N. Dencker: On the propagation of polarization sets for systems of real principal type. J. Funct. Anal., **46** (1982) 351-372.

[3] J. J. Duistermaat and L. Hörmander: Fourier integral operators. II. Acta math., **128** (1972) 183-269.

[4] V. Ya. Ivrii: Wave fronts of solutions of symmetric pseudodifferential systems. Siberian Math. J., **20** (1979) 390-405.

Adresses

P.J. Braam: The Mathematical Institute, 23-29 St. Giles, Oxford OX1 3LB, UK.

J.J. Duistermaat: Mathematical Institute, Utrecht University, P.O.Box 80.010, 3508 TA Utrecht, The Netherlands.

Tauber, Korevaar and the true nature of mathematics

T. Ganelius (Stockholm)

About 40 years ago I found that I had better study Jaap's thesis on approximation and interpolation if I wanted to get somewhere with my polynomial studies. When my Tauberian interest started to grow I soon found that Jaap had been in the field long before me. When I tried Muntz approximation I had the same experience, so when Jaap got too far ahead of me, I turned to dull administration and let my brightest students get in touch with him! That worked out so well that the University of Göteborg found it appropriate to confer an honorary doctor's degree on Jacob Korevaar in 1978. I shall try to fill in some mathematical details in this account.

Time dependent version of results in complex analysis and operator theory

I. Gohberg (Tel Aviv and Amsterdam)

This talk is a review of recent results which generalize a number of theorems from complex analysis and operator theory to the time dependent case. Often this generalization is connected with the complicated transition from matrix valued functions to infinite dimensional operators, from shifts to weighted shifts, from Toeplitz matrices to non-Toeplitz matrices, from equations with constant coefficients to equations with variable coefficients.

Attention will focus on theorems of interpolation, theorems concerned with orthogonal polynomials, and on results connected with index of operators.

The approach which allows the introduction of time is connected with system theory. Each rational matrix valued function can be represented as a transfer function of an input/output linear system with constant coefficients. The operators related to such functions are the input/output operators of those systems. Variable time is introduced by replacing the systems which have constant coefficients by systems with variable coefficients. In this more general case the transfer function no longer exists. However, the input/output operator plays the role for itself and for the transfer function.

The talk will be based on joint work with J.A. Ball, A. Ben-Artzi, and M.A. Kaashoek.

Potentials and rational approximations

A.A. Gončar (Moscow)

There will be discussed some new potential-theoretic problems related to the rate of rational approximation of analytic functions.

Integrals of analytic functions along two curves

W.K. Hayman (York)

Suppose that C_0 is the unit circle $|z| = 1$, and that C is a rectifiable Jordan curve, not identical with C_0, and whose interior contains $|z| < 1$. A proof will be given of the following conjecture of Harold Shapiro.

If $P(z)$ is a polynomial then

$$\int_{C_0} |P(z)| |dz| \leq K \int_C |P(z)| |dz|$$

where K is an absolute constant.

Envelopes of holomorphy and CR-invariant subsets of CR-manifolds

B. Jöricke (Berlin)

Let D be a relatively compact smoothly bounded strictly pseudoconvex domain in $\mathbb{C}^n$ $(n > 2)$. Let K be a compact subset of bD contained in a connected manifold $M \subset bD$. K is called removable if the envelope of holomorphy of $bD \setminus K$ is $\bar{D} \setminus K$, i.e., each function which is analytic on $bD \setminus K$ has analytic continuation to D.

Theorem 1. Let M have real dimension $2n - 3$. Then K is not removable iff $K = M$ (hence M is closed) and M is a maximally complex CR-manifold (hence M bounds an analytic variety of complex dimension $n - 1$).

Theorem 2. Let M have real dimension $2n - 2$ and suppose M is a generic CR-manifold. Then K is removable if K does not contain a compact set of one of the following types:

1. *A closed maximally complex CR-manifold of real dimension $2n - 3$.*
2. *A compact set similar to an exceptional minimal set in a codimension 1 foliation (such a set consists of maximally complex CR-manifolds of dimension $2n - 3$, each of which being complete in a natural metric on itself and neither locally dense in M neither open in its closure in M).*

Sets of both kinds can occur and can be obstructions for removability. They are minimal compact CR-invariant subsets of M, i.e., minimal sets which are invariant under moving along real curves being complex tangent. Theorem 2 is an analog of the theorem on polynomial convexity of totally real discs contained in convex boundaries in $\mathbb{C}^2$.

Uniform multi-parameter limit transitions in the Askey tableau

Tom H. Koornwinder (Amsterdam)

Originally, Jacobi, Laguerre and Hermite polynomials were together known as the classical orthogonal polynomials. The Askey tableau collects all families of orthogonal polynomials of non-q-type which still deserve to be called classical in a wider sense. The tableau has the form of a directed graph, where the arrows denote limit transitions. The various families depend on parameters and generally at least one parameter is lost in a limit transition. There are a number of instances, where one can descend from one family to another along various paths. It will be discussed in the lecture, how these paths can sometimes be taken together in the form of a uniform multi-parameter limit transition. The idea to consider the Askey tableau as a manifold with boundary will be pushed as far as possible.

Renewal sequences and the diagonal elements of the powers of positive operators

Wim Luxemburg (Pasadena)

A new inequality satisfied by the modulus of the resolvent of a positive linear operator (matrix) outside the spectral radius circle will be presented. One of the consequences of this inequality is that the sequences of the diagonal elements of the powers of positive linear operators are renewal sequences in the sense of Feller. It will be shown how the behavior of the analytic functions generated by such sequences influences the asymptotic behavior of the powers of the operators and their means (ergodicity properties).

Holomorphic embeddings of C in C^n

Walter Rudin (Madison)

If n is at least 2 and E is a discrete subset of $\mathbb{C}^n$ then there is a proper one-to-one holomorphic map F from $\mathbb{C}$ into $\mathbb{C}^n$ such that $F(\mathbb{C})$ contains E. If n is at least 3 a more precise result holds.

Complexifications of invariant domains of holomorphy

A.G. Sergeev (Moscow)

Let K be a compact Lie group, CK - its complexification. Let X be a complex space with the action of CK. For a domain D in X invariant under K we define its natural complexification CD. It is a domain in X which is invariant under CK given by $CD =$ the image of D under CK-action. We formulate geometric conditions on K-action on D which guarantee the following effects:

1) any K-invariant holomorphic function on D can be extended to a CK-invariant holomorphic function on CD;

2) if D is a domain of holomorphy then the same is true for CD.

These effects imply that CD is a natural holomorphic hull of D with respect to K-invariant holomorphic functions.

Analytic representation of distributions using wavelets

Gilbert G. Walter (Milwaukee)

The properties of the analytic representations of distibutions on the boundary of the unit disk are well understood. A principal tool in their construction and analysis is trigonometric Fourier series.

On the real line, no analogous theory based on orthogonal series seems to exist. Hermite series have the shortcoming that their analytic representations do not satisfy the same differential equation.

Recently a new category of orthogonal systems has appeared on the scene. These systems are composed of "wavelets", orthonormal functions on the real line consisting of dilations and translations of a fixed function. Each tempered distribution can be represented by a series of such wavelets. The analytic representations of the wavelets satisfy the same defining relation, in this case a "dilation equation".

In this talk we first present a short introduction to analytic and harmonic wavelets in a half plane. We then show series of these analytic wavelets can be used to define the analytic representation of functions and some tempered distributions.

Normal Families Revisited

Lawrence Zalcman (Ramat-Gan)

This lecture surveys recent progress in the theory of normal families of analytic and meromorphic functions on plane domains. A slight sharpening of the Main Lemma of [Z] yields extremely efficient (= one-line) solutions of all problems on normal families stated in [H] as well as a complete explanation of the phenomenon known popularly as "Bloch's Principle." An additional dividend of this approach is a short, new, and completely elementary proof of the Big Picard Theorem. Should time permit, extensions to complex analysis in higher dimensions will also be considered.

[H] W.K. Hayman, *Research Problems in Function Theory*, London, 1967.

[Z] Lawrence Zalcman, A heuristic principle in complex function theory, *Amer. Math. Monthly* 82 (1975), 813-817.

List of Participants

H.J. Alexander Department of Mathematics, University of Illinois at Chicago, M/C 249, Box 4348, Chicago IL 60680-4348, USA, e-mail: u22330@uicvm.bitnet

M. Anderson Department of Mathematics, University College, London University, Gowerstreet, London, WC1E 6BT, U.K. e-mail: ros@math.ucl.ac.uk

W. van Assche Department of Mathematics, Katholieke Universiteit Leuven, Celestijnenlaan 200B, B-3001 Leuven (Heverlee), Belgium, e-mail: walter=van=assche%twi%wis@cc3.kuleuven.ac.be

B. Berndtsson Department of Mathematics, Chalmers Institute of Technology, S-41296 Göteborg, Sweden, e-mail: bob@math.chalmers.se

F. van der Blij Faculteit Wiskunde en Informatica, Rijksuniversiteit Utrecht, Postbus 80010, 3508 TA Utrecht, The Netherlands

M.G. de Bruin Faculteit Technische Wiskunde en Informatica, Technische Universiteit Delft, Postbus 356, 2600 AJ Delft, The Netherlands, e-mail: debruin@dutiaw3.twi.tudelft.nl

N.G. de Bruijn Faculteit Wiskunde en Informatica, Technische Universiteit Eindhoven, Postbus 513, 5600 MB Eindhoven, The Netherlands, e-mail: debruijn@win.tue.nl

R.G.M. Brummelhuis Faculteit Wiskunde en Informatica, Rijksuniversiteit Leiden, Postbus 9512, 2300 RA Leiden, The Netherlands, e-mail: brummelhuis@rulwinw.leidenuniv.nl

P.L. Butzer RWTH Aachen, Lehrstuhl A für Mathematik, Templergraben 55, D-5100 Aachen, Germany, e-mail: ly010bu@dacth11.bitnet

C.K. Chui Department of Mathematics, Texas A&M University, College Station, TX 77843-3368, USA, e-mail: e443cc@tamvm1.bitnet

Z. Ciesielski Instytut Matematyczny PAN, ul. Abrahama 18, 81-825 Sopot, Poland, e-mail: zc@plearn.bitnet

Th.J. Dekker Van Uytrechtlaan 25, 1901 JK Bakkum, The Netherlands, e-mail: dirk@fwi.uva.nl

J.J. Duistermaat Mathematical Institute, Utrecht University, P.O.Box 80.010, 3508 TA Utrecht, The Netherlands, e-mail: duis@math.ruu.nl

J.M. Elkins Mathematical Sciences Department, Sweet Briar College, Sweet Briar, VA, USA, e-mail: elkins@alison.sbc.edu

P. van Emde Boas Faculteit Wiskunde en Informatica, Universiteit van Amsterdam, Plantage Muidergracht 24, 1018 TV Amsterdam, The Netherlands, e-mail: peter@fwi.uva.nl

M. van Frankenhuysen Katholieke Universiteit Nijmegen, Toernooiveld, 6525 ED Nijmegen, The Netherlands, e-mail: frankenh@sci.kun.nl

T. Ganelius Bergianska trädgården, S-104 05 Stockholm, Sweden

I. Gohberg Department of Mathematics, Tel Aviv University, Ramat-Aviv, Israel, e-mail: gohberg@taurus.bitnet, and Faculteit Wiskunde en Informatica, Vrije Universiteit Amsterdam, De Boelelaan 1081a, 1081 HV Amsterdam, The Netherlands

A.A. Gončar Steklov Institute, Vavilova 42, SU-117966, Moscow, Russia

W.K. Hayman Department of Mathematics, University of York, Heslington, York, Y01 5DD, U.K.

G. Hedstrom P.O. Box 808, LLNL, L-321, Livermore, CA 94550 USA, e-mail: hedstrom@physics.llnl.gov

E.M. de Jager Faculteit Wiskunde en Informatica, Universiteit van Amsterdam, Plantage Muidergracht 24, 1018 TV Amsterdam, The Netherlands

B. Jöricke MPG AG "Algebraische Geometrie und Zahlentheorie", Mohrenstrasse 39, O-1086 Berlin

M.A. Kaashoek Faculteit Wiskunde en Informatica, Vrije Universiteit Amsterdam, De Boelelaan 1081a, 1081 HV Amsterdam, The Netherlands, e-mail: kaash@cs.vu.nl

T.H. Koornwinder Faculteit Wiskunde en Informatica, Universiteit van Amsterdam, Plantage Muidergracht 24, 1018 TV Amsterdam, The Netherlands, e-mail: thk@fwi.uva.nl

J. Korevaar Faculteit Wiskunde en Informatica, Universiteit van Amsterdam, Plantage Muidergracht 24, 1018 TV Amsterdam, The Netherlands, e-mail: korevaar@fwi.uva.nl

R.A. Kortram Mathematisch Instituut, Katholieke Universiteit Nijmegen, Toernooiveld 5, 6525 ED Nijmegen, The Netherlands

A.B.J. Kuijlaars Faculteit Wiskunde en Informatica, Universiteit van Amsterdam, Plantage Muidergracht 24, 1018 TV Amsterdam, The Netherlands, e-mail: arno@fwi.uva.nl

A. Lukashov Vakgroep Wiskunde, Rijksuniversiteit te Groningen, Blauwborgje 3, 9747 AC Groningen, The Netherlands, alex@math.rug.nl

W.A.J. Luxemburg California Institute of Technology, A.P. Sloan Laboratory of Mathematics and Physics, Pasadena, CA 91125, USA, e-mail: marge@romeo.caltech.edu

T.L. McCoy Department of Mathematics, Michigan State University, East Lansing, MI 48824, USA

J.L.H. Meyers Ruyschstraat 61D, 1091 BW Amsterdam, The Netherlands, e-mail: jmeyers@fwi.uva.nl

M.A. Monterie Faculteit Wiskunde en Informatica, Universiteit van Amsterdam, Plantage Muidergracht 24, 1018 TV Amsterdam, The Netherlands, e-mail: marcelm@fwi.uva.nl

H.G. ter Morsche Faculteit Wiskunde en Informatica, Technische Universiteit Eindhoven, Postbus 513, 5600 MB Eindhoven, The Netherlands, e-mail: morscheh@win.tue.nl

A.B. Olde Daalhuis Centrum voor Wiskunde en Informatica, Kruislaan 413, 1098 SJ Amsterdam, The Netherlands, e-mail: aod@cwi.nl

P.J. de Paepe Faculteit Wiskunde en Informatica, Universiteit van Amsterdam, Plantage Muidergracht 24, 1018 TV Amsterdam, The Netherlands, e-mail: depaepe@fwi.uva.nl

P. Roos Kluwer Academic Publishers, P.O. Box 17, 3300 AA Dordrecht, The Netherlands, e-mail: scitech@kap.nl

A.C.M. van Rooy Mathematisch Instituut, Katholieke Universiteit Nijmegen, Toernooiveld, 6525 ED Nijmegen, The Netherlands

M.E. Rudin 110 Marinette Trail, Madison, WI 53705, USA, e-mail: mrudin@math.wisc.edu

W. Rudin 110 Marinette Trail, Madison, WI 53705, USA

R. Ryan Office of Naval Research, European Office, 223 Old Marylebone Road, London , NW1 5TH, U.K. e-mail: rryan@onreur.navy.mil

A.G. Sergeev Steklov Institute, Vavilova 42, SU-117966, Moscow, Russia, e-mail: armen@sergeev.mian.su

B. Silbermann Technische Universität Chemnitz-Zwickau, O-9010 Chemnitz, Germany

J.D. Stegeman Faculteit Wiskunde en Informatica, Rijksuniversiteit Utrecht, Postbus 80010, 3508 TA Utrecht, Netherlands, e-mail: stegeman@math.ruu.nl

D. Temme Faculteit Wiskunde en Informatica, Vrije Universiteit Amsterdam, De Boelelaan 1081a, 1081 HV Amsterdam, The Netherlands, e-mail: dirkt@cs.vu.nl

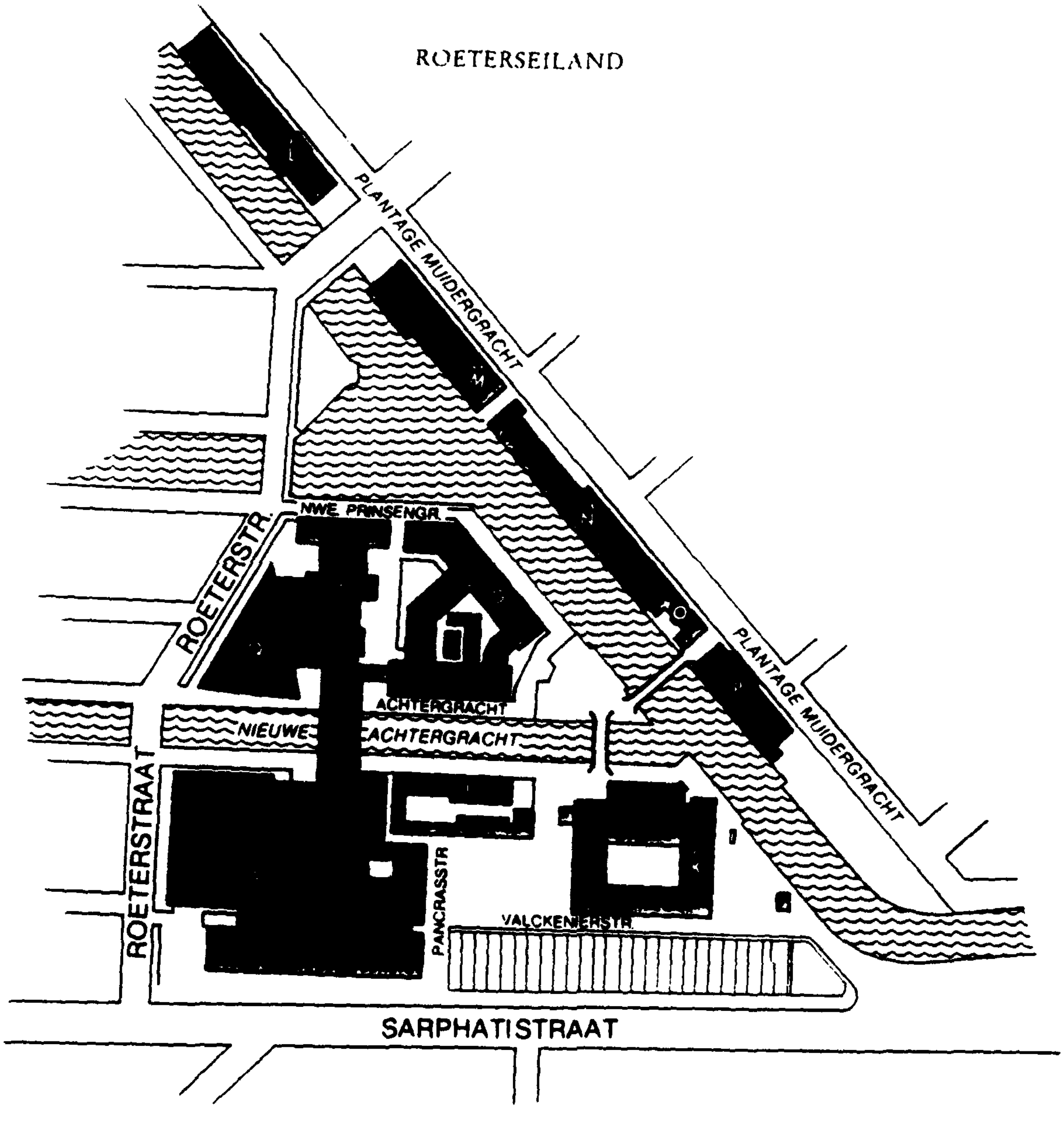
S.M. Verduyn Lunel Faculteit Wiskunde en Informatica, Vrije Universiteit Amsterdam, De Boelelaan 1081a, 1081 HV Amsterdam, The Netherlands, e-mail: verduyn@cs.vu.nl

G.G. Walter Department of Mathematics, University of Wisconsin-Milwaukee, Box 413, Milwaukee, WI 53201, USA, e-mail: ggw@convex.csd.uwm.edu

J.J.O.O. Wiegerinck Faculteit Wiskunde en Informatica, Universiteit van Amsterdam, Plantage Muidergracht 24, 1018 TV Amsterdam, The Netherlands, e-mail: janwieg@fwi.uva.nl

L. Zalcman Department of Mathematics and Computer Science, Bar-Ilan University, Ramat-Gan 52900, Israel, e-mail: f68403@barilan.bitnet

R.L. Zeinstra Dominikanerweg 36, 2848 Vechta, Germany



M. = Plantage Muidergracht 12 (lectures Wednesday & Thursday)
P. = Plantage Muidergracht 24 (lectures Friday morning)
Q. = Roetersstraat 11 (Lunches, Reception)
A. = Roetersstraat 15 (Lectures Friday afternoon)

Note that there is a convenient "over water" connection between Q. and A.

Program

Wednesday, January 27

Zaal MC3
Plantage Muidergracht 12
Amsterdam

9:00	9:45	Registration and coffee
9:45	10:00	F. van der Blij (Utrecht) *Welcome*
10:00	11:00	W. Rudin (Madison) *Holomorphic embeddings of $\mathbb{C}$ in $\mathbb{C}^n$*
11:15	11:55	H.J. Alexander (Chicago) *Linking and holomorphic hulls*
12:05	12:45	B. Berndtsson (Göteborg) *Estimates for the $\bar{\partial}$ equation in the one-dimensional case*
12:45	14:00	Lunch (Symposion, Roetersstraat 11)
14:00	15:00	L. Zalcman (Ramat Gan) *Normal families revisited*
15:15	15:55	W.K. Hayman (York) *Integrals of analytic functions along two curves*
16:15	16:55	A.A. Gončar (Moscow) *Potentials and rational approximation*
17:10	17:30	B. Jöricke (Berlin) *Envelopes of holomorphy and CR invariant subsets of CR manifolds*

Thursday, January 28

Zaal MC3
Plantage Muidergracht 12
Amsterdam

9:00	10:00	W.A.J. Luxemburg (Pasadena) *Renewal sequences and the diagonal elements of the powers of positive operators*
10:15	10:55	J.J. Duistermaat (Utrecht) *Normal forms of symmetric systems with double characteristics*
11:05	11:45	P.L. Butzer (Aachen) *Bernoulli and Euler "polynomials" with complex indices and the Riemann Zeta function*
12:00	12:40	T.H. Koornwinder (Amsterdam UvA) *Uniform multi-parameter limit transitions in the Askey tableau*
12:40	14:00	Lunch (Symposion, Roetersstraat 11)
14:00	15:00	N.G. de Bruijn (Eindhoven) *Convolutions of generalized functions, applied to diffraction theory of crystals and quasicrystals*
15:15	15:55	I. Gohberg (Tel Aviv and Amsterdam VU) *Time dependent version of results in complex analysis and operator theory*
16:15	16:55	Z. Ciesielski (Sopot) *Fractal functions and Schauder bases*
17:10	17:30	A.G. Sergeev (Moscow) *Complexifications of invariant domains of holomorphy*
19:00		Conference dinner (Restaurant Osaka)

Friday, January 29

Zaal P2.27
Plantage Muidergracht 24
Amsterdam

9:00	9:50	R.G.M. Brummelhuis (Leiden) *Approximate logarithmic convexity of means of solutions of elliptic equations*
10:00	10:20	T.L. McCoy (East Lansing) *Answer to a query concerning the mapping $w = z^{1/m}$*
10:40	11:00	G.G. Walter (Milwaukee) *Analytic representations of distributions using wavelets*
11:10	12:10	C.K. Chui (College Station) *Wavelets and affine frame operators*
12:10	13:30	Lunch (Symposion, Roetersstraat 11)

Zaal A
Roetersstraat 15
Amsterdam

13:30	14:30	T. Ganelius (Stockholm) *Tauber, Korevaar and the true nature of mathematics*
15:00	16:00	J. Korevaar (Amsterdam UvA) *Living in a Faraday cage*
16:00		Reception (Spiliazaal, Roetersstraat 11)